
Appendix B: Meridian 1 network loop capacity engineering for call centers

General procedure

A call center can consist of analog trunks or digital trunks, which terminate calls on the Meridian 1 system to be served by ACD agents. ACD calls can be simple agent served calls or complicated calls using features such as CCR, MAX, HER, HEVP or MIVR.

A system can be limited by physical or real-time constraints. Assuming that the configuration requirements are already known, use the following engineering procedure to estimate call center requirements:

- 1 Determine the number of loops required to equip the desired agent sets and trunks in the configuration.
- 2 Calculate real-time and signaling link requirements, based on the desired traffic per port (agent set or trunk).
- 3 Determine whether the required configuration is within the traffic/card slot and real-time capacity of the proposed Meridian 1 Option. The first resource (card slot/loop/real time) to reach the upper boundary is the limiting system capacity.

For the Option 11, the card slot is the only consideration for physical limitation. For larger Options, the network loop capacity is the only limiting factor. Following are the reasons:

- The Option 11 has a non-blocking network; behind each card slot is a loop of 32 time slots. There is no need to be concerned about running out of loops; a loop is provided for each card slot.

© 1997 Northern Telecom
All rights reserved

Printed in U.S.A.

Northern Telecom reserves the right to make changes in equipment, design or components as progress in engineering or manufacturing may warrant.

Meridian 1 and SL-1 are trademarks of Northern Telecom. Motorola is a trademark of the Motorola Corporation. MVME products are trademarked by the Motorola Corporation.

- With Enhanced Peripheral Equipment (EPE), there is a maximum port to time slot ratio of 160 to 30. With IPE, the port to time slot ratio can be 512 to 120 (or up to 512 to 480). The number of ports is always higher than the number of time slots. When a port must be non-blocking, as is generally required for an ACD trunk or agent in a call center environment, the time slots tend to run out faster than the card slots in a shelf.
- The half group single CPU Option 51 can be easily expanded to the full group dual CPU Option 61. Therefore, only the loop and redundancy requirements distinguish the two.
- The Network Module NT8D35 can be used to relieve the physical constraints of the Option 61 by providing space and power for the QPC720 PRI/DTI cards. Although the QPC414 network card still needs to reside in the NT6D39 CPU/Network Module, the possibility that the Option 61 with extra Network Module will run out of card slots is negligible.

To calculate the maximum load on a system, it is assumed that an ACD agent handles 33 CCS at an average of 180 seconds service time, which implies 18.3 calls per agent during the busy hour. This number may be reduced drastically if there is significant post call processing time involved with each call. In this case, 18 CCS and 10 calls per agent are more realistic default values.

An ACD trunk is assumed to carry 28 CCS with 180 seconds holding time, or 15.6 calls ($= 28 \times 100 / 180$) per trunk per hour. Non-ACD trunks have a default of 26 CCS per trunk. These default values in the calculation procedure may be replaced by specific numbers required by a customer for a given configuration.

Network loop capacity (Option 51-81/81C)

This section describes the general requirements for analog and digital trunk applications in the call center environment. The Option 11 hardware architecture differs from other Meridian 1 Options and it is discussed separately at the end of this appendix. Also, options not available with Release 22 are described briefly in this appendix.

The number of loops in a network group, including service loops, is 32. For practical applications, the traffic loops are limited to 28, reserving two loops each for TDS and conference. The Option 51 is a half-group system limited to 14 traffic loops.

Administrative sets and non-ACD trunks

Administrative sets and non-ACD related trunks usually comprise a call center. These sets and trunks must use regular rules to estimate loop requirements (660 CCS/loop, and 3500 CCS/superloop).

For EPE ENET Loops:

Number of loops for non-ACD set and trunk traffic = $N0e = [(No. \text{ of Adm. sets} \times 6 + No. \text{ of non-ACD trunks} \times 26)/660] +$

For IPE XNET Loops:

Number of loops for non-ACD set and trunk traffic = $N0x = [(No. \text{ of Adm. sets} \times 6 + No. \text{ of non-ACD trunks} \times 26)/875] +$
and $N0 = N0e + N0x$

The above calculations account for blocking ENET and XNET loops. To simplify the calculation procedure, a superloop of 3500 CCS is divided into 4 equivalent ENET loops at 875 CCS each. This makes the number of total loops in the system a constant regardless of peripheral equipment vintage.

$[] +$ means use the next higher integer, or “round-up.” For example, $[4] + = 4$ and $[3.1] + = 4$.

To simplify the notation in this document, the “+” at the upper right corner of the bracket is omitted. Therefore, $[x]$ denotes rounding up x to the next highest integer.

The default value of 6 CCS per set and 26 CCS per trunk can be replaced by actual numbers for a particular site if they are given. Note that the default trunk traffic assumed for non-ACD applications is lower than that of an ACD trunk (28 CCS).

Agent sets and ACD analog trunks

When the system serves as a call center, it is most likely equipped with more trunks than agent sets (lines). The reason for having a higher number of trunks is that there are calls in the queue which engage trunk circuits but not ACD agents until they are served. In addition, in an NACD application, the overflowed calls continue to occupy trunks without the service of agents at the source node. However, this trunk to agent ratio may change if a service requires a long post call processing time from an agent. In this case, CCS per agent must be reduced, reflecting the actual agent service time associated with calls to the Meridian 1 CPU.

For the examples in this section, the default values used are 33 CCS and 18.3 ($= 33 \times 100 / 180$) calls per agent during the busy hour. For applications requiring long post call processing time, 18 CCS and 10 calls per agent are more accurate default values.

Based on the standard Meridian 1 engineering rule, a loop can handle 660 CCS and a superloop can handle 3500 CCS. When an agent is loaded to 33 CCS, it means that a loop can equip 20 agents ($= 660 / 33$) and a superloop 106 ($= 3500 / 33$); both numbers are less than their respective number of time slots (30 for loop, 120 for superloop), and hence are not reasonable.

This shows that the normal network engineering rule for the Meridian 1 does not apply in a call center environment, because the “infinite traffic source” assumption in the Erlang loss model is violated.

We will therefore ignore the traffic model and equip 30 agents per loop and 120 agents per superloop and still have a non-blocking network. A superloop was created to take advantage of the traffic theory that a bigger server group is more efficient than a number of smaller ones. This is no longer true in a

non-blocking application, because a superloop can be replaced by four loops without impact to capacity. We will ignore superloops in the subsequent calculations. If IPE is desired, divide the required number of loops by four to get the equivalent number of superloops (except for a DTI/PRI loop which has to be an EPE loop).

For the purpose of loop requirement calculations, an agent supervisor set is treated like an agent set, however, its call intensity is reduced for real-time calculations.

Following is the calculation procedure for loop requirements. Let the number of agent sets be L1, the number of supervisor sets be L2, the number of ACD analog trunks be Ta, and the number of RAN trunks be Tr:

Number of non-blocking loops for agent sets, Supervisor sets and ACD analog trunks = $N1 = [(L1 + L2 + Ta + Tr) / 30]$

DTI/PRI trunks

At an average of 28 CCS per trunk, a loop of 660 CCS can equip 23 ($=660/28$) trunks. It is more practical to equip 24 trunks per PRI/DTI loop as a rule rather than doing traffic calculations. Let Td be the number of DTI trunks and Tp be the number of PRI trunks.

The equations for trunk loop calculation are as follows:

Number of loops for DTI trunks, $N2d = [Td / 24]$

Number of loops for PRI trunks, $N2p = [(Tp + 2) / 24]$

Number of loops for digital trunks, $N2 = N2d + N2p$

When a back-up D-channel is not provided, the term $(Tp + 2)$ in the equation for PRI trunks can be replaced by $(Tp + 1)$.

When the number of analog trunks is small (for example, 15 or less), it may be included in the N0 calculation to reduce the loop requirement.

For an international version of PRI, 24 ports should be replaced by 30 in the above calculations. Loop blockings are not affected by equipping 30 trunks to 30 channels due to the implementation of "time slot reuse" in the international software. The rest of the engineering procedure is the same.

Loops for music and Meridian Mail applications

Music (MUS) in Meridian 1 is provided by broadcasting a music source to a conference loop. Therefore, a maximum of 30 users can listen to music at one time. This may be sufficient for most applications. If it is not, an additional conference loop must be provided for each additional 30 simultaneous music users.

Meridian Mail ports are interfaced with a loop to provide voice channels for messaging. The network to interface Meridian Mail must be an ENET. Every 24 ports in the Meridian Mail is interfaced with one loop. However, due to the increment of 16 ports per Meridian Mail node, a loop is able to equip only 16 Meridian Mail ports.

The conference loop connects to one half of the TDS/CON card. The second conference loop, if needed, takes up another card and card slot, because it cannot be separated from the TDS loop.

Calculation procedure:

$N31 = \text{[Music ports/30]}$

$N32 = \text{[Meridian Mail ports for Meridian Mail or MIVR or HEVP/16]}$

Number of loops for applications, $N3 = N31 + N32$

Physical capacity in loops

The following procedure can be used to calculate NL, the total number of network loops required in the system:

$$NL = N1 + N2 + N3$$

The number of loops required are checked against the number of loops available for each Option of the Meridian 1. It is assumed that two TDS/CON cards provide two TDS loops and two conference loops are always equipped per network group. The number of loops in the following equations refers to traffic loop only:

$NL \leq 14$ Option 51/51C

$14 < NL \leq 28$ Option 61/61C

$28 < NL \leq 140$ Option 71/81/81C

Only additional service card requirements above the default two equipped TDS/CON cards need to be accounted for in these equations.

The CPU capacity requirement usually determines whether a “C” model should be equipped for each Option.

Physical capacity of the Option 11C

System overview

The main difference in architecture between the Option 11 and the larger Meridian systems is that it extends the CPU bus to XPE slots, thus eliminating the network bus. This architecture skips one level of bit-to-byte and byte-to-bit conversion, and also eliminates a phase lock loop circuit to synchronize the DS-30 5MHz timing to the Meridian-1 network bus 8 MHz timing.

The Option 11C is the latest version of the small system which started with the Option 11, evolving to the Option 11E. The hardware described in this section is based on the Option 11C. The procedure to make the Option 11C engineering procedure applicable to older Option 11s is discussed at the end of this Appendix.

The Option 11C consists of a base cabinet and up to two expansion cabinets. The base cabinet comprises the Small System Controller (SSC) card and 10 XPE slots. The SSC pack consists of CPU, Memory, Network Conference and Ethernet controller. Each expansion cabinet has 10 XPE card slots.

Any PRI, BRA, RAN, XDLC, XUT pack or Meridian Mail takes up one XPE slot. Meridian Mail must be installed in the tenth slot of the base cabinet. The system with expansion cabinets has a maximum of 30 card slots. The system line/trunk capacity is reduced when features requiring XPE slots for interface and service circuits are deployed.

The Option 11C main cabinet may be connected to one or two expansion cabinets by mounting Fiber Expansion daughterboards (NTDK22 or NTDK24) in the base cabinet. The expansion daughterboard provides an additional 16 channels of conferencing capabilities. Each expansion cabinet requires a Fiber Receiver card (NTDK23AA/25AB) in card slot 0.

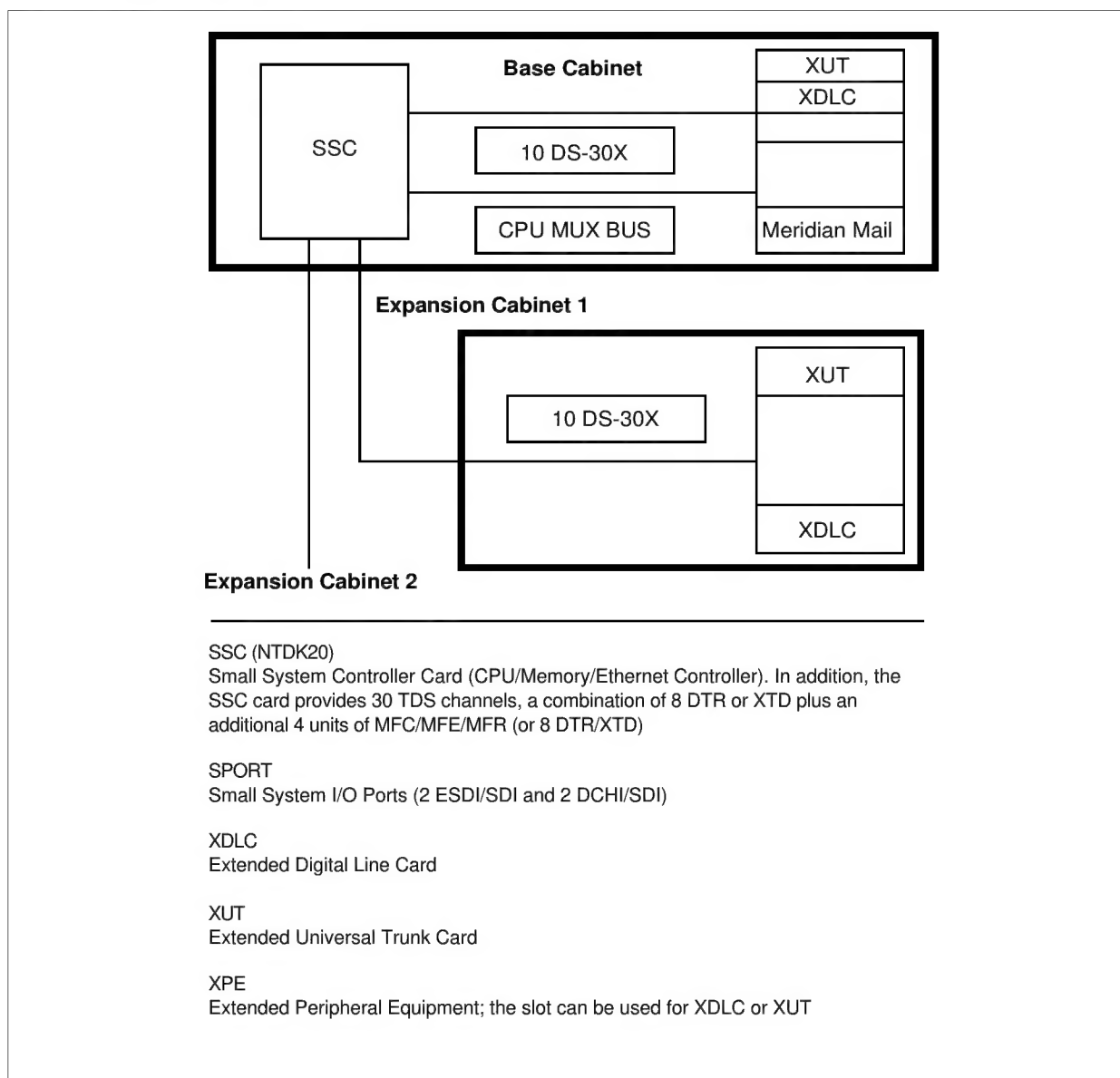
Packs requiring direct access to the CPU bus, such as PRI and TDS, are supported in the base cabinet only.

The system backplane at the cabinet provides DS-30X interface (32 timeslots) to each XPE slot. Since a card has only 8, 16, 24, or 30 ports, the interface ensures that at least one timeslot is available to every port.

The basic building blocks in the system are the XPE hardware of the 16-port line card (XDLC), the 8-port trunk card (XUT), and the 24-port/30-port PRI card.

A simplified block diagram of the base cabinet and the expansion cabinet is shown in Figure 12.

Figure 12
Option 11C block diagram



Network requirement calculation

Each cabinet, base or expansion, has 10 XPE card slots. Meridian Mail can be equipped only in the 10th slot of the base cabinet. Allow for only 9 slots in the base cabinet for general traffic calculations to ensure that the 10th slot is available for Meridian Mail. In case Meridian Mail is not needed, the slot may be used for tones or other service circuits which are not included in the calculation. The engineering procedure provides for a quick manual check of physical requirements. For exact equipment provisioning, refer to the Meridian Configurator.

The basic rule in the procedure allows for 9 card slots in the base cabinet and 10 card slots in each expansion cabinet. The physical capacity limit of an Option 11C is 29 card slots.

This implies that service circuits in SSC are sufficient for general applications. Any applications requiring supporting service cards, such as MFC, MFR or extra DTR/XTDs, and TDS reduces the number of card slots available for trunks and lines.

For the purpose of card slot calculation, an agent supervisor set is treated like an agent set, however, its call intensity is reduced for real-time calculations.

Agent sets and analog trunks

An XDLC card can accommodate 16 agent sets, and an XUT analog card can serve 8 trunks. The numbers of ports per card are used as the basis of calculations in this document. Note that any other cards used with different port numbers will change the equation, thereby requiring further adjustments.

Let L = the number of lines, agent sets and supervisor sets, T = the number of trunks, and N1 = the number of XPE slots for agent sets and analog trunks.

Calculation procedure:

Number of slots for agent sets with analog trunks = $N1 = [L/16] + [T/8]$

If $N1 > 29$, the configuration requirement exceeds the capacity of an Option 11C. Also note that even before the card slots run out, a voice line capacity of 384 is imposed on the Option 11C and 11E, and a 224 limit is imposed on the Option 11. These are extra thresholds which must be checked.

Agent sets and PRI trunks

This configuration requires that all PRI cards (NTAK09 1.5 Mbyte) be equipped in the base cabinet from slot 1 through 9. Although Clock Controller (NTAK20) and D-channel (NTAK93) cards are needed for PRI applications, they are daughterboards used in conjunction with the PRI card and therefore, do not take up an XPE slot. Ignore them for the purpose of calculating card slot requirements.

Assuming no extra service cards are needed, there are 9 XPE slots available (from slots 1 to 9) for a maximum of 9 PRI cards in the base cabinet. The maximum number of B-channels (trunks) is 214 ($=24 \times 9 - 2$, assuming 2 D-channels). If we assume that all 20 slots in expansion cabinets are equipped with agents, the maximum number of agents is 320 ($=20 \times 16$). This is the maximum possible configuration in a PRI application. However, it is not a practical configuration, since the number of agents is greater than that of the trunks.

When the number of digital trunks in a configuration exceeds 214, no further calculation is necessary, since the Option 11C is not large enough to meet the digital trunk requirement.

The following equation provides the calculation procedure for digital trunks.

Calculation procedure:

Number of slots for agent sets with digital trunks = $N2 = [L/16] + [(T + 2) / 24]$.

If $N2 > 29$, the configuration requirement exceeds the capacity of an Option 11C. When a back-up D-channel is not needed, the term $(T + 2)$ in the equation can be replaced by $(T + 1)$.

For an international version PRI, 24 ports should be replaced by 30 in the above calculations. The maximum number of digital trunks are increased proportionally. The ratio of trunks to agents should remain in the 1.1 to 1.5 range. The rest of the engineering procedure for the international PRI is the same.

Slots for RAN, MUS, Meridian Mail and applications

Ports in a trunk card can be configured to provide RAN or MUSic service. Except for very special applications, one XUT card is usually sufficient for this type of service. It is always assumed that one XUT is adequate in the following procedure.

To provide ESDI ports for AML applications, such as CCR or HER, a SPORT card is needed.

Calculation procedure:

Number of slots for service ports = $N3 = 1$ (for RAN/MUS) + 1 (for Meridian Mail) + 1 (for AML/CCR/HER)

Since there are 3 SDI ports on the SSC card, we assume that there is no need to add a DCH/SDI card (NTAK02) for additional SDI ports with applications. However, if the port on the CPU card is reserved for maintenance, and the total number of SDI ports required are more than two for applications (MAX and CDR), a DCH/SDI card will be needed.

Physical limit

The following procedure can be used to calculate N_t , the total number of card slots required in the system:

$N_t = N_1 + N_3$, for agent sets and all analog trunks.

$N_t = N_2 + N_3$, for agent sets and all digital trunks.

When a system allows mixed analog and digital trunks, the total number of slots can be calculated as follows:

$N_t = N_1 + N_2 + N_3$, for agent sets and mixed analog and digital trunks.

Note that in the mixed trunking case, the agent slot calculation in N1 and N2 ([L/16]) needs to follow some special rules:

If the agents serving analog trunks require different skills from those serving digital trunks, separate calculation procedures are required.

If both types of trunks are served by the same agent group, the total combined agents should be used to do the slot calculation. This will avoid the rounding off error which could occur when an agent group is combined from two subgroups which were rounded-up independently of each other.

If the total number of card slots (Nt) is less than or equal to 9, it means that one base cabinet is sufficient to meet the configuration requirement.

If $19 \geq Nt > 9$, the configuration can be served by the Option 11C with one expansion cabinet.

If $29 \geq Nt > 19$, the configuration can be served by the Option 11C with two expansion cabinets.

If $Nt > 29$, the configuration requirement cannot be met by an Option 11C.

The loop and card slot calculation procedure is illustrated in Example 1 of Appendix C, "Meridian 1 CPU capacity engineering."

Adjustment of rules for Option 11 and Option 11E

The Option 11C is an enhanced version of Option 11E in several areas, such as CPU, memory, conference channels, and so on. As far as physical capacity is concerned, they are identical. Therefore, all the above rules and limits are applicable to the Option 11E.

The Option 11 is the first generation of the small system. It allows only one expansion cabinet, and the CPU card has less functionality than either 11C or 11E. It requires an extra card to provide I/O ports (SPORT). Therefore, the rule should be 8 slots in the base cabinet and 10 slots in the expansion cabinet for Option 11.

Note that only Option 11C is supported on Release 22.